

FOURTEENTH BIENNIAL REPORT

OF THE

COMMISSIONERS

OF THE

GEOLOGICAL AND NATURAL  
HISTORY SURVEY

Covering the Period from  
July 1, 1922 to June 30, 1924



MADISON, WISCONSIN  
Democrat Printing Company  
1924



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## GEOLOGICAL AND NATURAL HISTORY SURVEY

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*President of the University of Wisconsin.*

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*President of the Wisconsin Academy of Sciences, Arts, and Letters.*

## STAFF OF THE SURVEY

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### ADMINISTRATION:

WILLIAM O. HOTCHKISS, State Geologist, Director and Superintendent. In immediate charge of the Geology Division.  
ERNEST F. BEAN, Assistant State Geologist.  
LILLIAN M. VEERHUSEN, Chief Clerk.  
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### GEOLOGY DIVISION:

WILLIAM O. HOTCHKISS, In charge.  
ERNEST F. BEAN, Assistant State Geologist.  
HENRY R. ALDRICH, Geologist.  
THOMAS C. CHAMBERLIN, Consulting Geologist, Pleistocene Geology.  
EDWARD O. ULRICH, Consulting Geologist, Stratigraphy, by cooperation of the U. S. G. S.  
RAY HUGHES WHITBECK, Geographer.  
FREDRIK T. THWAITES, Geologist, Well Records, Educational Rock Collection.

### NATURAL HISTORY DIVISION:

EDWARD A. BIRGE, In charge.  
CHAUNCEY JUDAY, Lake Survey.  
FRANK C. BAKER, Fresh Water Mollusca.  
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GEORGE WAGNER, Fish.  
BERNHARD P. DOMOGALLA, Chemistry.

### DIVISION OF SOILS:

ANDREW R. WHITSON, In charge.  
WARREN J. GEIB, Inspector and Editor.  
FREDA E. HANZLIK, Clerk and Stenographer.  
THEODORE J. DUNNEWALD, Field Assistant and Analyst.  
GEORGE D. SCARSETH, Field Assistant and Analyst.  
WILLIAM H. PIERRE, Field Assistant.  
CASSIUS D. LUTTRELL, Field Assistant.  
ARTHUR H. MEYER, Field Assistant.

## LETTER OF TRANSMITTAL

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Commissioners of the Wisconsin Geological and Natural History Survey, Madison.

Office of the President.

HONORABLE JOHN J. BLAINE,  
*Governor of the State.*

SIR: I have the honor to transmit herewith the report of Mr. W. O. Hotchkiss, Director and Superintendent of the Geological and Natural History Survey, for the biennial period extending from July 1, 1922 to June 30, 1924.

During the biennial period the Survey has carried on its investigations along the lines which have been followed in the past, excepting that the work on mineral possibilities of northern Wisconsin was changed in 1922 from work relating chiefly to iron ore to areas in which the chief mineral possibility is copper. For a detailed account of the work which has been accomplished I refer you to the report of the Director transmitted herewith.

Very respectfully yours,

E. A. BIRGE, *President.*



## REPORT OF THE DIRECTOR OF THE SURVEY

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To the Commissioners of the Geological and Natural History Survey:

Gentlemen: I submit herewith my biennial report as Director and Superintendent of the Wisconsin Geological and Natural History Survey, covering the period from July 1, 1922 to June 30, 1924.

In the fiscal year ending June 30, 1923, the income for the Survey was as follows:

General Appropriation: Section 20.42 (a)-----\$55,000.00\*

In the fiscal year 1923-1924 the income was:

General Appropriation: Section 20.42 (a)-----\$55,000.00\*

Special Appropriation: Section 20.42 (d)---  
(Road Materials Survey) available March 1, 1924-----10,000.00

Total Appropriation ----- \$65,000.00

\* Of this amount there was allotted not to exceed \$15,000.00 for the preparation of a topographic map of the state of Wisconsin.

### I. PERSONNEL OF THE SURVEY

The names of the persons employed permanently by the Survey and those who have given any considerable amount of time to the Survey in conducting independent investigations are shown on the second page of this report. In addition to these persons, others have been employed for short periods as draftsmen, assistants in field parties, stenographic assistants, etc. It is not necessary to give a complete list of these persons here, as the report of the Secretary of State contains the names of the persons employed, together with the amounts received by each. The kind of work in which each of the principal employees of the Survey was engaged is shown in a general way on

the page where they are listed and the following report gives these lines of activity in more detail.

## II. FINANCIAL STATEMENT.

In the following table I have summarized the expenditures of the Survey according to departments, thus indicating the main direction in which the money appropriated by the state has been expended. The result is as follows:

	1922-23	1923-24
Administration -----	\$5,624.13	\$4,469.40
Geology:		
State Geologist's Office -----	5,972.13	5,622.03
Road Material Survey -----	.00	2,559.73
Limestones -----	200.00	.00
Physiography -----	.00	.00
Stratigraphy -----	.00	147.56
Geography -----	.00	.00
Topography -----	12,759.87	12,747.03
Areal Geology -----	.00	42.43
Minor Investigations -----	710.71	508.02
Mineral Land Classification -----	9,144.88	12,556.97
Mine Valuation -----	500.00	500.00
Lakes -----	6,529.22	5,493.35
Soils -----	10,188.06	10,892.60
Totals -----	\$51,629.00	\$55,529.21

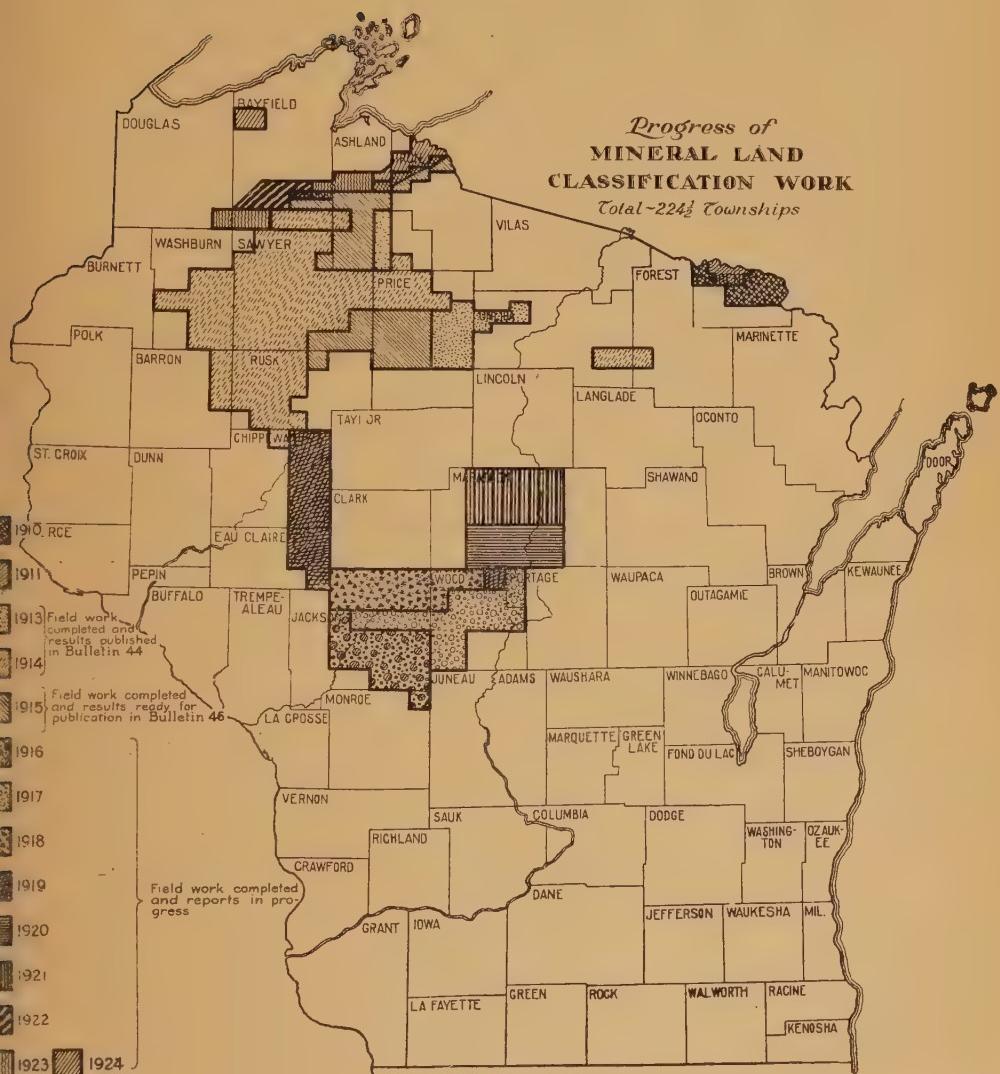
## III. THE WORK OF THE SURVEY.

The work of this organization covers a wide range of scientific, economic and educational subjects. In order to have the various activities carried out under the supervision of men well qualified to guide them to the best advantage, the work is divided into the following three divisions:

- A. Geology, in charge of State Geologist Hotchkiss.
- B. Natural History, in charge of President Birge.
- C. Soils, in charge of Prof. A. R. Whitson.

### A. GEOLOGY, IN CHARGE OF W. O. HOTCHKISS.

1. *Classification of Mineral Lands.* The purposes of this branch of the Survey's work are to make a complete geological examination of the central and northern portions of the state with the principal object of ascertaining what indications of valuable geological resources may be found. This part of the state has never been given a thorough geological study.



This work was started in 1913 and has been continued every year since that time. The area is studied by township units—36 square miles—and wherever there has been immediate demand for information a preliminary map has been issued of each unit during the winter after the close of the field work.

In general the method of work is to traverse the area on the north-south section and quarter lines of the government land survey, with closer traverses wherever indications are found to warrant the additional work. In these traverses observations are made of the various kinds of ledge rock that exist, and data are collected on the glacial deposits. In this way, stone, gravel, sand and clay deposits are located that may be of value for roads, building construction or other local or general needs. By careful observations of the local magnetic attractions such evidence of possibilities of mineral deposits as may be present is obtained. This evidence serves to guide anyone who wishes to explore with the drill to the most promising localities for this work. Of just as great value is the saving to citizens of the state by giving them the fact that in most places there is an utter lack of evidence to warrant the expenditure of money for exploration.

In 1922, because of the availability of men best qualified for this particular work, the scene of work was shifted to the area where copper is the chief mineral possibility. Before 1922 the work has been confined to the areas where the chief mineral possibility is for iron ore.

In 1923 about six townships in Douglas, Ashland and Bayfield Counties were examined. This area, and the areas covered in preceding years, are shown on the accompanying map.

In 1924 about five townships were examined in Ashland, Iron, and Bayfield Counties.

The ancient lava flows in which the great copper deposits of northern Michigan are found have long been known to extend southwest from Houghton in a continuous belt across northwestern Wisconsin, from Hurley to St. Croix Falls. Twenty-three years ago, in 1899 and 1900, this Survey employed Prof. U. S. Grant to examine portions of the area of copper bearing rocks where exploration was being carried on. The results of his work were published as bulletin No. VI. It is planned to extend this work over the whole area of copper bearing rocks. The history of areas known to possess possibilities for valuable

minerals indicates that there is a renewal of exploring activity about once every 20 to 30 years. It is the purpose of this Survey to have the geological work done before any renewal of exploration occurs and so be able to furnish those who wish to risk the large amounts of money necessary for effective exploration the best information possible as a guide for their expenditure.

In 1922 very important results were obtained that will be of much value to the explorer. It was shown that outcrops far apart can be definitely correlated by careful magnetic surveys, and this work was done in a large area. The existence of a hitherto unknown fault of great magnitude was strongly indicated, a fact that will be of much use to the prospector in his drilling.

During the field season of 1923 six townships were surveyed, three in extension of the 1922 work to the eastward and three to the southwest. Native copper was found to occur in very promising quantities toward the southwest and the evidence of the great fault was greatly strengthened. To the eastward the rocks of the copper-bearing series have been subjected to igneous intrusions of complex character and have suffered rather intense modification. The copper possibilities here were found to be quite different from and decidedly less than those of areas lacking the intrusions. A second important fault was located.

In this last season—1924—extension of the work to the southwest was postponed in order to insure completion of the area eastward as far as the Montreal River and the state boundary. This objective was attained, and the area of intrusives was carefully delimited. During the course of this work additional cross faults were disclosed.

The progress of the work was more rapid than contemplated so that one party moved to the north side of the basin and succeeded in surveying 54 square miles on the extreme east end of the Douglas County Range. Here, in an area absolutely devoid of outcrops, application of the magnetic methods, which have been the main stay of this work to date, gave strong indication of unsuspected structures apparently correlating with those determined in 1922 on the south side.

Thus a start was made on the north side in Western-Bayfield County in order that the work of next season might be more intelligently planned. The copper range of Douglas County has

long been considered one of the more promising localities for copper exploration. Its exposures, however, are for most part confined to the north margin of the belt leaving the southern boundary to be mapped by projecting strikes long distances from exposures. By employing magnetic methods this drift-covered boundary should be easily detected and followed accurately, thereby relegating certain areas now suspected of being mineral land to classification as non-mineral-bearing. In other places no doubt the converse will be true.

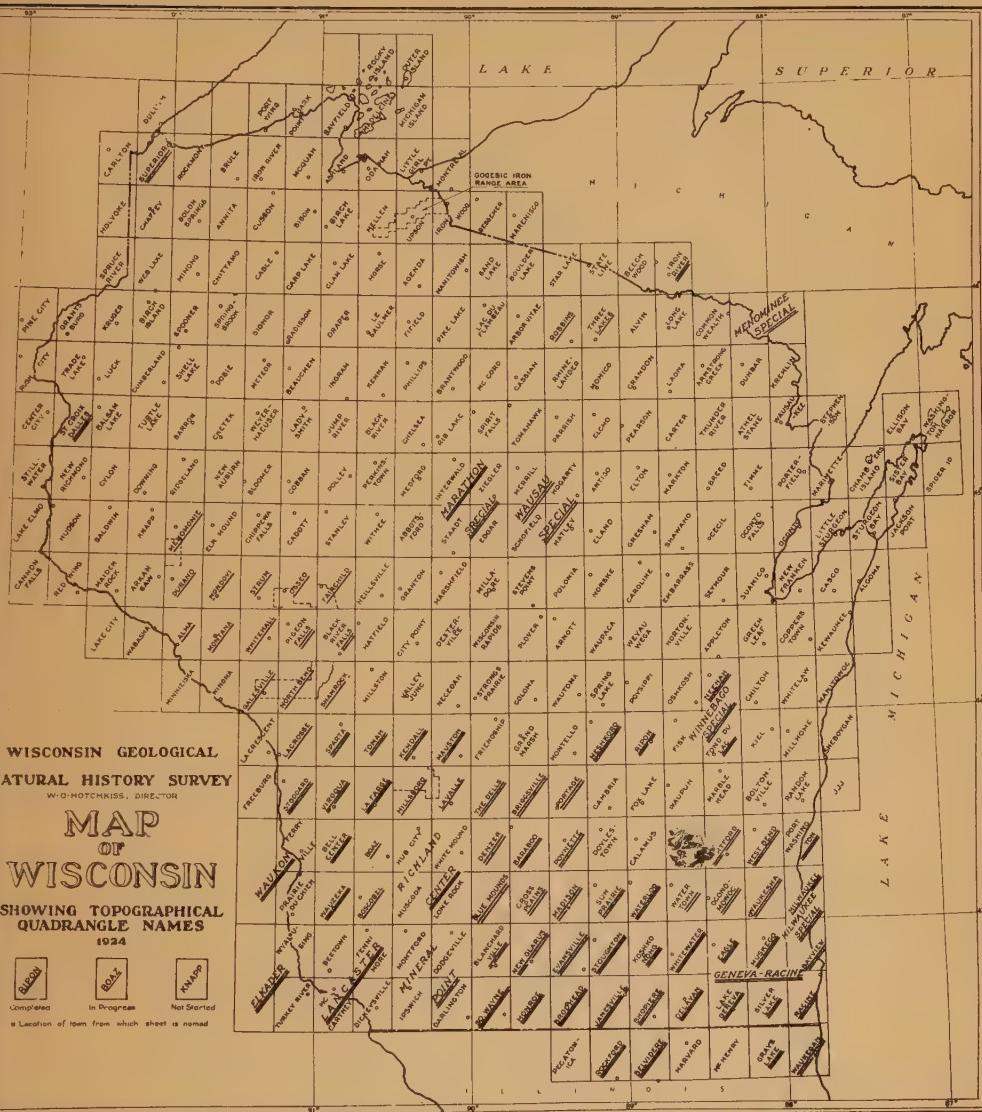
2. *Mine Valuation.* The duty of securing for the Tax Commission certain information relating to valuing the mines was put upon the Survey by the legislature of 1913. A general discussion of the methods and purposes of the work was given in the ninth biennial report and need not be repeated here.

3. *Topographic Maps.* This work is carried on in cooperation with the United States Geological Survey, each paying half of the field and office expense of preparing the maps for the engraver. The expense of engraving and printing is borne by the United States Geological Survey.

In the past two years work has been continued in the Boaz, Bell Center, Hillsboro, La Farge, Viroqua, Stoddard, Shamrock, North Bend, Galesville, Black River Falls, Pigeon Falls, White-hall, Osseo and Strum sheets. Field work was completed and proof maps received for the Viroqua and La Farge sheets. The final engraving and printing of these has not been completed as yet. Work has been started in the Mondovi, Alma, Wauzeka, and Boscobel sheets. Final engraving was completed and sheets published for the following areas: Blue Mounds, Blanchardville, New Glarus and South Wayne.

Owing to the very urgent need for these maps in the hilly western part of the state, to aid in highway relocations, the whole of the work in the two years as in the past has been concentrated in this region. Every sheet surveyed in this hilly country will save more than its cost in the one item of highway surveys and construction alone, and yet with the small amount of money available the maps of the state will not be completed for 100 years, while the roads will be permanently located and built long before that. This will result in paying for these maps twice before we get them.

A much larger sum should be spent by the state each year in making these maps which are so fundamental and necessary for



all engineering undertakings. Road building, railroads, telephones, transmission lines, land drainage,—all these require the information given by topographic maps. If the maps are not available these various public services must each make its own surveys with the result that the public ultimately pays the cost and yet *does not get the map.*

The areas which have been completed are shown on the accompanying map of the state. The location of the town for which the sheet is named is shown by a dot.

4. *Limestones.* The bulletin by Mr. Steidtman on Limestones of Wisconsin for which the manuscript was completed at the time the last biennial report went to press was delayed due to lack of time for editing and did not get to the printer until this past summer. The printed volume should be off the press not later than December 1924. It will fill a valuable place on the bookshelves of those who are interested in such resources—particularly as agriculture is rapidly awakening to the value of these materials on the soils. The Marls and Clays which constitute the chief resources for the manufacture of portland cement are discussed quite fully in this volume.

5. *Road Material Investigations.* During the past biennium Mr. E. F. Bean has continued to devote practically his whole time to the search for road materials. The last legislature made an appropriation of \$10,000 per year for this work, this fund being available on March 1, 1924. Before this time approximately half of Mr. Bean's salary was paid by the Wisconsin Highway Commission.

It has been known for some time that this work results in large savings to the public. In 1923, 114 miles of concrete paving were built from local pits. The cost of building this mileage with rail-hauled sand and gravel was computed and showed a saving of over half a million dollars due to the use of local pits, or about \$5,000 per mile in freight, unloading charges, and truck haul.

The search for concrete paving materials is, however, not the most important work. A very large proportion of the highways of Wisconsin can carry traffic in an entirely satisfactory fashion with other and much cheaper surfacings, such as gravel, limestone, shale, disintegrated granite, sand, or clay. For this reason a large part of the road materials work is directed to the search for the cheaper surfacings. Thorough search for local

road materials by trained geologists almost invariably results in the discovery of previously unknown deposits, thus producing one or more of the following benefits: (1) net cost of transportation is reduced due to the saving in haul, (2) a better material is found, and (3) the finding of new competitive material results in a lower price paid to the owner.

During the summer of 1924 road material surveys were for the first time made for towns. This work has been particularly helpful, as the finding of previously unknown deposits of gravel and disintegrated granite has made possible the surfacing of town roads at a moderate cost. In one case the town chairman reported that the finding of one previously unknown deposit was worth many times the cost of the survey. This service has greatly reduced the cost of surfacing town roads, thus making more surfaced roads possible. Since funds are not sufficient to permit us to make surveys free for all the towns that might apply, road materials surveys were made for those towns willing to pay \$100 to cover a part of the cost of the work. In this way it was assured that assistance would be given where most needed and where the results would be used to the fullest possible extent.

The road material appropriation has made it possible for the Survey to be of assistance to the counties in locating maintenance material—limestone quarry sites in the southwestern part of the state, shale pits in the sandstone area, disintegrated granite in north central Wisconsin, and gravel elsewhere. One such survey covering 60 miles of road reported upon 34 undeveloped and 8 developed shale deposits.

The road material surveys are annually saving many hundreds of thousands of dollars for the tax payers of Wisconsin. The work should be expanded so that the Survey may be of even greater service in effecting savings to the public in the cost of construction and maintenance of all roads in the state.

6. *Stratigraphy.* This work which has been carried on in the past by Dr. E. O. Ulrich of the U. S. Geological Survey for a few weeks each season has been continued in the past two years as usual. The contribution of this survey to this work has consisted only in the payment of Dr. Ulrich's field expenses. A brief report of progress was published by Dr. Ulrich, with the permission of the Director of the U. S. Geological Survey, in the last volume of the Proceedings of the Wisconsin Academy of

Sciences, Arts, and Letters. This gives the detailed succession of beds in the southern, eastern and western parts of the state.

This work has been of the most abstract scientific character. Fossil remains of the various shell fish which inhabited the sea-bottoms in which these sandstones and shales and limestones were deposited have been laboriously collected and studied with minute care in order to identify the particular beds from which they came. And yet this scientific work, undertaken with little thought of its having practical value—started and continued as a small side issue to the main expenditures of the Survey—has been of immediate practical use of great importance. A large area in the western part of the state covering thirteen or fourteen counties is dependent for its road material chiefly on shale or limestone. Limestone must be quarried and crushed and so is expensive. Shale can be dug with a pick and shovel and is therefore cheap. This work of Dr. Ulrich has made it possible to locate shale beds with a minimum of effort and time and has therefore disclosed to us the cheapest road material in this section of the state.

In 1924 detailed mapping of the various rock beds was started in the Kendall and La Farge sheets. The Survey was fortunate in enlisting the interest of the Milwaukee Public Museum in this work, and making a cooperative arrangement with that institution whereby the Museum put Mr. Ira Edwards—the curator of geology—in the field to carry on this mapping. The Museum paid the salaries of the geologist and his assistant, Mr. Gilbert Raasch, and the Survey paid the field expenses. This work was done on the Kendall sheet.

Mr. Thwaites and an assistant mapped the La Farge sheet.

**7. Well Data.** Mr. Thwaites has continued to collect data on deep wells drilled in the state, and has examined the samples sent in by the drillers. By the information thus accumulated he is able to advise as to the particular rock beds that yield the largest or best water supplies. Many cities, villages and private individuals, and industries are aided by this advice and enabled to save thousands of dollars in unnecessary drilling.

In 1923 an article was published in the Journal of Geology giving to the public the results of this work up to the time of publication. Copies of this article were secured so they could be furnished well drillers, public officials and others needing the information.

The Survey cooperates with the State Board of Health in the work of advising municipalities as to securing adequate water supplies.

8. *General Services.* In its capacity of a general scientific bureau of the state, the Survey is called upon for many different kinds of service not directly related to its own work. The state geologist is ex-officio a member of the State Highway Commission and has given much time to the work of this body. Last year, against his advice—he urged that one of the appointive members should fill the place—he was made chairman of the commission. The duties of this position take more of his time than ever before.

In connection with the interstate boundary controversy Mr. Hotchkiss and Mr. Aldrich have been called upon to examine the boundary and advise with the Attorney General's department.

The state geologist was appointed by Gov. Blaine as a member of the committee to examine into the matter of floods on the Upper Fox and Lower Wolf rivers.

At the request of the editor of the Blue Book, three articles have been prepared for the 1925 volume by Mr. Bean and Mr. Hotchkiss, discussing the geology, the physiography, and the geography and industries of the state in a popular manner.

In its turn the Survey has received valuable cooperation from the State Superintendent's department in relation to the educational series of bulletins on geology and geography of the state.

The Survey has cooperated with the State Board of Health, and the State Engineer in various matters.

In addition to these services directly rendered to other state departments there are many inquiries from private citizens over the state with regard to the kind and value of the minerals they have found on their land and how they may be marketed if they have value. Land owners, investors, executors of estates, commercial associations, bankers, cities and villages, railway companies, teachers and pupils have many questions to ask with regard to the various resources, and the geology of the state. Letters from various departments of the state government and the university are referred to the Survey for answer.

Many samples are sent in with a request for analysis or assay. As the survey has no laboratory of this sort it is impossible to comply with such requests, but usually the inquiry can be ade-

quately answered after an examination of the specimen. In practically all cases the inquirer can be told definitely whether his material contains anything of value, and an expensive analysis is only warranted if there are valuable constituents present. The advice thus given without charge saves many hundreds of dollars to citizens of the state each year.

9. *Statistics of Wisconsin Mineral Production.* Since 1912 the State Survey has been cooperating with the United States Geological Survey in collecting statistics of Wisconsin mineral production. In this work a great mass of valuable information has been obtained at practically no expense to the state.

The following tables show the important facts with regard to mineral production in Wisconsin:

## MINERAL PRODUCTION OF WISCONSIN, 1914-1918

Product	1914			1915			1916			1917			1918		
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	
Clay products, short tons		\$950,999		\$910,558		\$905,910		\$1,122,121		\$1,122,121		\$874,172			
Iron ore	1,178,610	1,125,269	2,188,012	1,529,459	3,644,542	1,179,709	3,913,437	1,167,640	3,796,408						
Sold to furnaces, long tons					1,599	( <sup>a</sup> )	982	2,597	5,026						
Sold for paint, long tons					423,973	47,534,327	402,732	511,032,274	363,225	b13,832,308					
Iron, pig, long tons	33,350,199	302,913	53,997,940	218,268	3,043	419,334	4,139	71,1908	4,533	643,686					
Lead, short tons	116,532	2,322	871,820	221,147	755,986	266,805	1,207,059	169,650	1,037,578	109,303	740,700				
Lime, short tons	227,469														
Mineral paints															
Natural pigments, short tons	2,339	23,390	4,017	53,547	1,051,405	7,636,813	1,507,619	6,296,634	1,362,498	6,630,725	1,183,345				
Mineral waters, gallons sold	5,145,432	568,373	4,861,734	7,639,125	67,625	277	259,928	376	376	376	376	376			
Potash K <sub>2</sub> O, short tons															
Pyrites, long tons	14,188	78,460	13,985	43,254	( <sup>a</sup> )										
Sand and gravel, short tons	3,594,336	768,996	2,862,036	689,915	3,544,766	894,202	3,609,869	1,080,860	2,170,312	809,884					
Sand and lime brick, thousands		86,682		94,064											
Stone, short tons	2,516,156			2,412,741			2,757,790			2,787,023					
Zinc, short tons	31,113	41,403	10,267,344	66,303	15,223,204	59,742	15,187,368	50,014	2,382,456	3,102,548					
Miscellaneous		3,662,193	4,023,207		5,251,992		9,017,291		11,711,577						
Total value eliminating duplications		\$11,140,365		\$19,795,588		\$27,082,175		\$24,916,780		\$20,091,146					

<sup>a</sup>Value included under "Miscellaneous".<sup>b</sup>Value not included in total value for state.<sup>c</sup>Exclusive of pottery, value for which is included under "Miscellaneous".

## MINERAL PRODUCTION OF WISCONSIN 1919-1923

Product	1919		1920		1921		1922		1923	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay products, short tons.										
Iron ore	\$1,203,757		\$1,413,255		\$1,665,644					
Sold to furnaces, long tons	3,253,290	1,067,159	4,333,307	1,117,755	300,954	\$2,455,660				
Sold for paint, long tons	88,740	1,645	(a)	1,455	3,411					
Iron, pig, long tons	1,086	363,588	b) 12,355,028	93,666	b) 2,730,156					
Lead, short tons	282,380	446,684	423,520	972	87,480					
Lime, short tons	4,214	2,647	1,583,027	124,078	999,407	691				
Mineral paints	123,620	1,094,725	144,590		189,588	1,389,931				
Natural pigments, short tons										
Zinc-lead pigments, short tons	(ab)		(ab)		(ab)					
Mineral waters, gallons sold	5,113,289	1,446,367	5,259,447	1,601,075	5,665,797	1,726,333	6,126,143	2,120,669	6,977,448	2,612,452
Potash K <sub>2</sub> O, short tons	392	247,496	119,542	(a)	(a)					
Pyrites, long tons	26,033	1,9,287	(a)	(a)	(a)					
Sand and gravel, short tons	2,763,249	1,543,434	2,422,689	1,553,322	2,889,809	1,783,178	3,433,986	1,957,624	5,021,608	2,733,399
Sand-lime brick, thousands	(a)		(a)	17,1167	215,988	4,995	148,351			
Stone, short tons	1,556,880	3,179,894	1,564,940	3,728,236	1,743,770	3,569,929	1,800,230	3,310,387		
Zinc, short tons	40,765	5,951,690	27,285	4,420,170	3,390	339,000	10,932			
Miscellaneous		9,876,580		12,234,975		6,155,013				
Total value eliminating duplications		\$18,772,601		\$19,630,114		\$9,990,961				

<sup>a</sup>Value included under "Miscellaneous".<sup>b</sup>Value not included in total value for state.<sup>c</sup>Exclusive of pottery, value for which is included under "Miscellaneous."

## PRODUCTION OF LIME BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Dodge.....	36,875	\$313,281	76,563	\$690,051
Manitowoc.....	76,377	632,067	85,171	780,026
Sheboygan.....	11,109	91,454	15,758	152,563
Other counties.....	65,197	553,129	50,057	433,006
Total.....	189,558	\$1,589,931	227,549	\$2,055,646

## PRODUCTION OF GRAVEL BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Dane.....	(a)	(a)	74,771	\$38,616
Fond du Lac.....	11,508	17,154	(a)	(a)
Green.....	(a)	(a)	34,564	13,580
Manitowoc.....	10,192	2,590	26,272	8,068
Marathon.....	(a)	(a)	40,341	29,768
Milwaukee.....	46,265	40,277	96,943	79,393
Portage.....	32,174	21,743	120,616	40,908
Rock.....	292,710	147,442	551,718	231,549
Sauk.....	57,590	41,431	21,858	19,175
Sheboygan.....	120,959	83,212	133,332	115,832
Waukesha.....	439,323	286,002	727,621	552,240
Other counties.....	786,647	462,052	637,552	381,090
Total.....	1,797,368	\$1,101,903	2,465,588	\$1,510,219

<sup>a</sup>Included under "Other counties".

## PRODUCTION OF GRANITE BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Marathon.....	4,245	\$520,685	36,139	\$713,985
Marinette.....	2,651	190,500	2,439	178,789
Waushara.....	117,449	362,540	136,069	648,391
Other counties.....	33,298	340,705	46,933	394,427
Total.....	157,643	\$1,414,430	221,580	\$1,935,592

## PRODUCTION OF LIMESTONE BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Buffalo.....	14,500	\$15,579	(a)	(a)
Calumet.....	(a)	(a)	70,719	\$65,612
Dodge.....	126,318	105,784	149,409	148,575
Fond du Lac.....	85,831	89,400	55,927	63,269
Manitowoc.....	6,132	5,267	6,418	6,032
Milwaukee.....	132,311	203,566	(a)	(a)
Outagamie.....	41,005	43,876	33,696	48,011
Rock.....	4,874	9,680	(a)	(a)
Sauk.....	(a)	(a)	18,910	21,440
Waukesha.....	236,704	251,815	267,193	285,423
Winnebago.....	59,527	72,587	70,959	103,739
Other counties.....	619,498	604,266	1,203,994	1,268,649
Total.....	\$1,826,700	\$1,401,820	1,877,225	\$2,010,750

<sup>a</sup>Included under "Other counties."

## PRODUCTION OF MINERAL WATER BY COUNTIES

County	1922		1923	
	Amount sold Gallons	Total value of sales	Amount sold Gallons	Total value of sales
Milwaukee.....	821,288	\$76,839	796,276	\$77,000
Waukesha.....	4,125,503	2,015,776	5,982,643	2,496,955
Other counties.....	1,179,352	28,054	248,529	38,497
Total.....	6,126,143	\$2,120,669	6,977,448	\$2,612,452

## PRODUCTION OF MOLDING SAND BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Columbia.....	(a)	(a)	28,896	\$17,261
Green Lake.....	18,334	\$13,091	41,523	30,135
Other counties.....	63,182	48,441	70,576	77,584
Total.....	81,516	\$61,532	140,995	\$124,980

<sup>a</sup>Included under "Other counties."

## PRODUCTION OF SAND BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Columbia	23,316	\$14,975	28,896	\$17,261
Fond du Lac	12,462	17,580	3,807	4,970
Green Lake	18,334	13,091	41,523	30,135
Milwaukee	110,913	71,096	157,680	172,030
Rock	624,405	207,521	1,060,610	346,801
Sheboygan	82,395	47,974	67,166	44,083
Waukesha	270,799	167,213	433,065	228,692
Other counties	494,004	316,271	758,273	439,808
Total	1,636,628	\$855,721	2,556,020	\$1,283,780

## PRODUCTION OF SANDSTONE BY COUNTIES

County	1922		1923	
	Short tons	Value	Short tons	Value
Dunn	9,686	\$38,099	15,741	\$47,099
Sauk	173,161	264,175	191,864	315,821
Other counties	43,634	79,363	32,775	49,074
Total	226,481	\$381,637	240,380	\$411,994

10. *Educational Bulletins.* One of the duties imposed by statute on this Survey is the preparation of bulletins on the geography and natural history of the state in such form as to serve as manuals in the public schools. Six such bulletins have been issued, and the editions of the first four have been exhausted. These bulletins have served well to help acquaint people with our great state, and have assisted in giving them a better appreciation of its industries, scenery, and geography.

The bulletin on "Geography of Southwestern Wisconsin" was delayed by editing but was sent to the printer in June, 1924 and should be off the press before the end of the year. It will be of much use in the schools to teach the geography and resources of this part of the state.

The report on the Sparta-Wilton area which is to be printed by the U. S. Geological Survey has been delayed.

B. NATURAL HISTORY DIVISION, UNDER THE DIRECTION OF  
PRESIDENT BIRGE.

Investigations on the various lakes of the state have been continued during the past biennium.

The U. S. Bureau of Fisheries has continued to give financial aid in this work and this assistance is gratefully acknowledged.

The University of Wisconsin has also continued to give financial assistance from its Research Fund for some of the work of this Division.

*1. Major Investigations.*

(a) The quantitative studies of the flora and fauna of Green Lake were completed in 1924. The results obtained by Mr. H. W. Rickett for the large aquatic plants were embodied in a report which has just been published in Volume XXI of the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters.

A report dealing with the data relating to the plankton and to the bottom fauna is now being prepared for publication.

(b) The determination of the average weight and of the chemical composition of various aquatic organisms is still in progress.

(c) During the past two years, a study of the quantity and of the chemical composition of the organic substances held in solution by the waters of several Wisconsin Lakes, has been made in cooperation with the University of Wisconsin. This investigation was completed in June, 1924, and a report is now being prepared for publication.

*2. Other Investigations.*

(a) The second part of Dr. G. M. Smith's report on the plankton algae of Wisconsin lakes is now in press.

(b) The second part of the report on the Rotifera of Wisconsin, prepared by Mr. H. K. Harring of the Bureau of Standards, Washington, D. C. and Mr. Frank J. Myers of Atlantic City, N. J., has just been published in Volume XXI of the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters. A third part of this report will be ready for publication early in 1925.

(c) The report on the aquatic Mollusca of Wisconsin, prepared by Mr. Frank C. Baker, Curator of the Natural History Museum of the University of Illinois, is completed; it will be published as soon as funds are available.

(d) The report dealing with the bacteria of Lake Mendota is now in press.

## C. SOIL SURVEY, IN CHARGE OF PROFESSOR WHITSON.

During the past biennum the work of the detailed Soil Survey has been pushed as rapidly as means would permit. The field work has been completed in the counties of Green Lake, Green, Pierce, and Monroe and is now under way in Sheboygan, and Sauk Counties. As the information collected by this Survey accumulates, a continually increasing demand for it is being made. This is particularly true with reference to various extension agencies of an agricultural character, and especially the county agents. Among other important requests which might be mentioned is that for assistance and information in connection with the location of factories for the canning of peas, beans, corn, cabbage, etc. This industry is increasing in the State with remarkable rapidity.

Effort is being made to collect as much information of practical value incidental to the regular work of the Survey as possible. As mentioned in the last report, a special study of the lime content of soils low in that element was begun. This year a study of the income and outgo of phosphorus as it affects soil fertility has been undertaken in Sheboygan County. Many assessors are finding the reports and maps of assistance in their efforts to adjust taxes more nearly in accordance with land values for agricultural use.

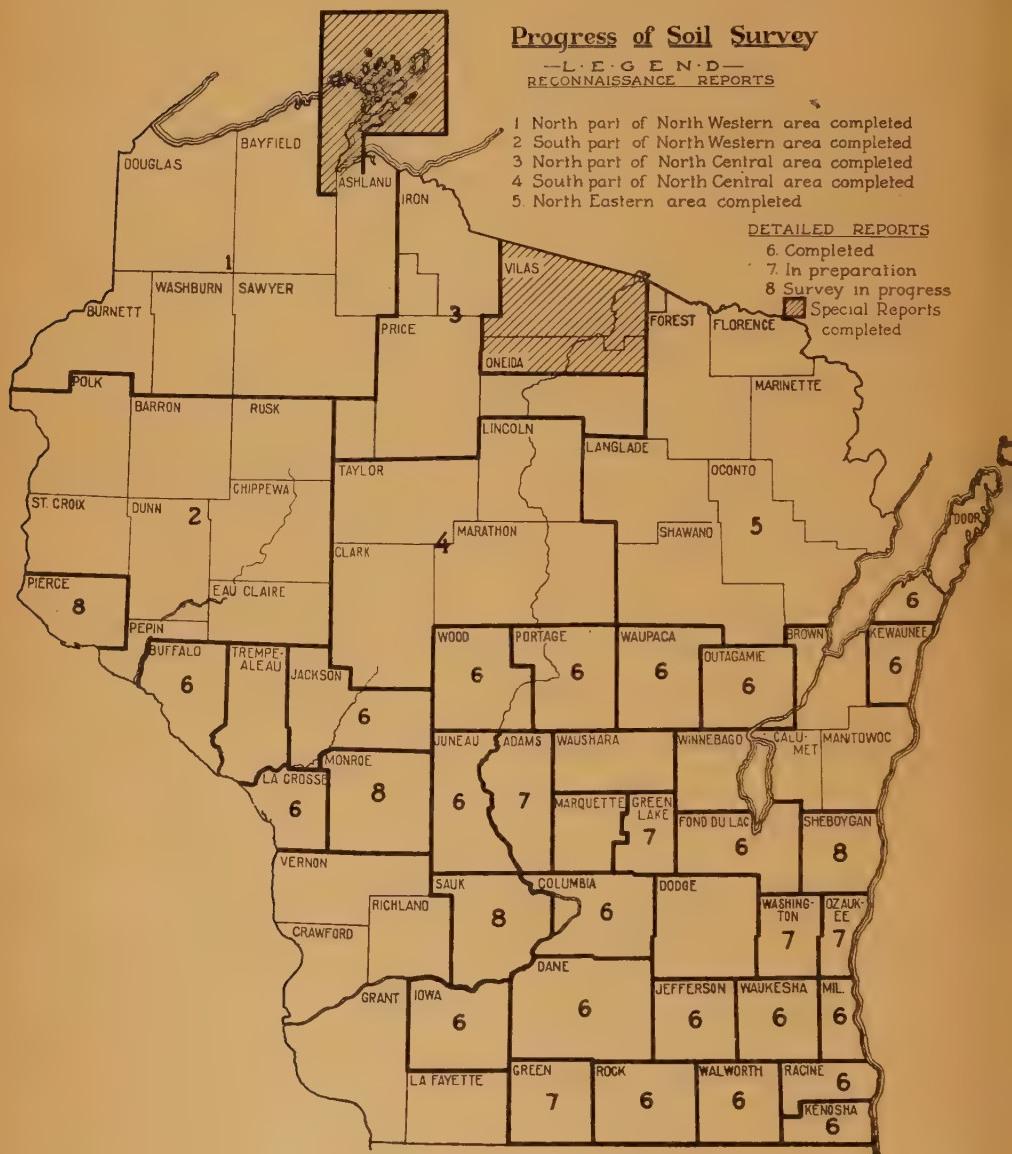
The Survey has had in preparation for some time a general map and report on the soils of the State. It is hoped that this map and report will be published within the coming biennium. This report will furnish information on a large variety of subjects which it is now necessary to give in letter form and will put the information collected by the Survey in much more available form than that in the several county reports.

## DETAILED SURVEY

Name of area	No. of square miles	No. of soil types	Field work conducted	Condition of report and map
Waushara County	628.3	14	1909	Out of print
Bayfield Area	329.0	7	1909	Published
Iowa County	758.5	13	1909-1910	Published
Waukesha County	553.7	20	1909-1910	Published
Fond du Lac County	722.3	17	1910-1911	Out of print
La Crosse County	472.4	18	1910-1911	Published
Juneau County	798.1	16	1910-1911	Published
Kewaunee County	341.5	21	1911	Published
Columbia County	779.9	27	1911	Published
Jefferson County	552.8	27	1912	Published
Dane County	1,195.4	45	1912-1913	Published
Buffalo County	699.0	17	1911-1913	Published
Wood County	807.6	26	1915	Published
Portage County	817.7	42	1915	Published
Door County	477.7	20	1916	Published
Milwaukee County	238.4	24	1916	Published
Rock County	714.5	22	1916-1917	Published
Waupaca County	752.1	29	1916-1917	Published
Jackson County	997.4	25	1917-1918	Published
Outagamie County	641.1	22	1917-1918	Published
Kenosha County	268.0	30	1918	Published
Racine County	333.6	30	1919	Published
Walworth County	558.1	32	1919-1920	In preparat'n
Adams County	679.2	30	1919-1920	In preparat'n
Washington County	429.6	44	1920-1921	In preparat'n
Ozaukee County	231.7	44	1920-1921	In preparat'n
Green Lake County	352.0		1921-1922	In preparat'n
Green County	579.6		1921-1922	In preparat'n
Pierce County	578.8		1922	In preparat'n
Monroe County	910.8		1922	In preparat'n
Sheboygan County	510.0		1924	Being surv'y'd
Sauk County	320.0		1924	Being surv'y'd

## RECONNOISSANCE SURVEY

Name of Area	No. of square miles	No. of soil types	Field work conducted	Condition of report and map
Reconnaissance of N. E. Wisconsin, including: Forest County Florence County Marinette County Oconto County Shawano County Langlade County	6,020	29	1912-1913	Published
Reconnaissance of Forest Reserve Area	576	10	1913-1914	Edition exhausted
Reconnaissance of North Part of North Central Wisconsin including: Vilas County Oneida County Iron County Price County	3,834	33	1913-1914	Published
Reconnaissance of South Part of North Central Wisconsin including: Lincoln County Marathon County Taylor County Clark County	4,582	30	1915	Published
Total reconnaissance under cooperative agreement	15,012			
Reconnaissance by state alone: North part of N. W. Wisconsin, including: Ashland County Bayfield County Douglas County Burnett County Washburn County Sawyer County	6,323	14	1911-1912	Edition exhausted
South part of N. W. Wisconsin, including: Eau Claire County Chippewa County Rusk County Barron County Dunn County Pepin County Pierce County St. Croix County Polk County	6,705	14	1909-1910	Edition exhausted
Total Reconnaissance by state alone	13,028			
Total Detail	18,198.8			
Total	46,238.8			



#### IV. PUBLICATIONS.

During the biennial period the following publications have been issued. These are described in the list which follows:

- |                   |                     |
|-------------------|---------------------|
| Bulletin No. 54B. | Soil Series No. 24. |
| Bulletin No. 56B. | Soil Series No. 29. |

The following reports are being prepared:

- Mineral Land Classification, by W. O. Hotchkiss, E. F. Bean, and H. R. Aldrich.  
Lake Temperatures, by Dr. E. A. Birge.  
The Rotifera of Wisconsin, by H. K. Harring.  
The Mollusca of Wisconsin, by F. C. Baker.  
General Map and Report on the Soils of the State, by Prof. A. R. Whitson et al.

PUBLICATIONS  
OF THE  
WISCONSIN GEOLOGICAL AND NATURAL HISTORY  
SURVEY

The publications of the Survey are issued as (1) bulletins, which are numbered consecutively, (2) road pamphlets, (3) biennial reports, and (4) maps. These publications are independently paged and indexed, no attempt being made to group them in volumes.

1. BULLETINS.

The bulletins are issued in four series:

*Scientific Series*.—The bulletins so designated consist of original contributions to the geology and natural history of the state, which are of scientific interest rather than of economic importance.

*Economic Series*.—This series includes those bulletins whose interest is chiefly practical and economic.

*Educational Series*.—The bulletins of this series are primarily designed for use by teachers and in the schools.

*Soil Series*.—This includes the bulletins prepared by the Soils Division.

The following bulletins have been issued:

*Bulletin No. I. Economic Series No. 1.*

On the Forestry Conditions of Northern Wisconsin. Filibert Roth, Special Agent, United States Department of Agriculture. 1898. Pp. vi, 78; 1 map. *Out of Print.*

*Bulletin No. II. Scientific Series No. 1.*

On the Instincts and Habits of the Solitary Wasps. George W. Peckham and Elizabeth G. Peckham. 1898. Pp. iv, 241; 14 plates, of which 2 are colored; 2 figures in text. Sold at the price of \$1.50 in paper.

*Bulletin No. III. Scientific Series No. 2.*

A Contribution to the Geology of the Pre-Cambrian Igneous Rocks of the Fox River Valley, Wisconsin. Samuel Weidman, Ph. D. 1898. Pp. iv, 63; 10 plates; 13 figures in text. *Out of Print.*

*Bulletin No IV. Economic Series No. 2.*

On the Building and Ornamental Stones of Wisconsin. Ernest Robertson Buckley, Ph. D. 1898. Pp. xxvi, 544; 69 plates, of which 7 are colored, and 1 map; 4 figures in text. Sent on receipt of \$2.50 Ed. v.m.

*Bulletin No. V. Educational Series No. 1.*

The Geography of the Region About Devil's Lake and the Dalles of the Wisconsin with some notes on its surface geology. Rollin D. Salisbury, A. M., Professor of Geographic Geology, University of Chicago, and Wallace W. Atwood, B. S., Assistant in Geology, University of Chicago. 1900. Pp. x, 151; 38 plates; 47 figures in text. *Out of Print.* Ed. v.m.

*Bulletin No. VI. Economic Series No. 3. Second Edition.*

Preliminary Report on the Copper-Bearing Rocks of Douglas County, and parts of Washburn and Bayfield Counties, Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1901. Pp. vi, 83; 13 plates. Sent on receipt of 50 cents. Ed. iiim. mdccl.

*Bulletin No. VII. Economic Series No. 4.*

The Clays and Clay Industries of Wisconsin. Part 1. Ernest Robertson Buckley, Ph. D. 1901. Pp. xii, 304; 55 plates. Sent on receipt of 50 cents. Ed. v.m.

*Bulletin No. VIII. Educational Series No. 2.*

The Lakes of Southeastern Wisconsin. N. M. Fenneman, Ph. D., Professor of General and Geographic Geology, University of Wisconsin. 1902. Pp. xv, 178; 36 plates; 38 figures in text. A second edition has been issued and is sold at the price of 50 cents. Ed. iim.

*Bulletin No. IX. Economic Series No. 5.*

Preliminary Report on the Lead and Zinc Deposits of Southwestern Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1903. Pp. viii, 103; 2 maps; 2 plates; 8 figures in text. *Out of Print.* Ed. iim.

*Bulletin No. X. Economic Series No. 6.*

Highway Construction in Wisconsin. Ernest Robertson Buckley, Ph. D. 1903. Pp. xvi, 339; 106 plates, including 26 maps of cities. Sent on receipt of 50 cents. Ed. v.m.

*Bulletin No. XI. Economic Series No. 7.*

Preliminary Report on the Soils and Agricultural Conditions of North Central Wisconsin. Samuel Weidman. 1903. Pp. viii, 67; 10 plates, including soil map. Second edition, 1908. *Out of print.* Ed. viii.

*Bulletin No. XII. Scientific Series No. 3.*

The Plankton of Lake Winnebago and Green Lake. Dwight Marsh, Ph. D., Professor of Biology, Ripon College. 1903. Pp. vi, 94; 22 plates. *Out of print.* Ed. md.

*Bulletin No. XIII. Economic Series No. 8.*

The Baraboo Iron-Bearing District of Wisconsin. Samuel Weidman, 1904. Pp. x, 190; 23 plates, including geological map. *Out of print.* Ed. iiim.

*Bulletin No. XIV. Economic Series No. 9.*

Report on Lead and Zinc Deposits of Wisconsin. Ulysses Sherman Grant, Ph. D., Professor of Geology, Northwestern University. 1906. Pp. ix, 100; 8 plates; 10 figures in text; an atlas containing 18 maps. This report is out of print, but the 18 maps which formerly accompanied it are still available, and will be sent on receipt of 20 cents. Ed. iiimd.

A supplementary series of 6 maps including the Montfort, East Mineral Point, Ipswich, Big Patch, Elk Grove, Cuba City, and East Meeker's Grove sheets—by W. O. Hotchkiss and Edward Steidtmann—was issued in 1909. Sent on receipt of 6 cents.

In 1914 a series of 7 large scale blue prints were issued (Scale 1 in. = 400 ft.) They were prepared in coöperation between the Geological Survey and the State Mining Trade School, by R. E. Davis and W. O. Hotchkiss, and give in great detail data on lead crevices, mine workings, pitches and underground crevices. They cover areas about Hazel Green, Benton, New Diggings, Platteville, Mifflin, the East End mine and the Coker mine. These maps are about 3x4 feet. They are sold at the cost of making the blue prints—at 25 cents per sheet.

*Bulletin No. XV. Economic Series No. 10.*

The Clays of Wisconsin and Their Uses. Heinrich Ries, Ph. D., Assistant Professor of Economic Geology, Cornell University. 1906. Pp. xii, 259; 30 plates, including 2 maps, 7 figures in text. Sent on receipt of 50 cents. Ed. iiim.

*Bulletin No. XVI. Scientific Series No. 4.*

The Geology of North Central Wisconsin. Samuel Weidman. 1907. Pp. xxxi, 697, 86 plates, including 2 maps; 38 figures in text. Sent on receipt of \$2.00. Ed. iiim.

*Bulletin No. XVII. Scientific Series No. 5.*

The Abandoned Shore-lines of Eastern Wisconsin. J. W. Goldthwait, Ph. D., Assistant Professor of Geology, Northwestern University. 1907. Pp. x, 134; 38 plates; 37 figures in text. Sent on receipt of 50 cents. Ed. imd.

*Bulletin No. XVIII. Economic Series No. 11.*

Rural Highways of Wisconsin. W. O. Hotchkiss. 1906. Pp. xiv, 135; 16 plates; 2 figures in text. Sent on receipt of 25 cents. Ed. xivm; viiim.

*Bulletin No. XIX. Economic Series No. 12.*

Zinc and Lead Deposits of the Upper Mississippi Valley. H. Foster Bain, Director of State Geological Survey of Illinois. Washington, D. C. 1907. Pp. xii, 155; 9 plates, including 5 maps; 45 figures in text. Sent on receipt of 25 cents.

This bulletin is a reprint of Bulletin No. 294 of the United States Geological Survey. *Only a small number of copies were reprinted for local use. It has not been sent out to libraries and exchanges.*

*Bulletin No. XX. Economic Series No. 13.*

The Water Powers of Wisconsin L. S. Smith, C. E.; Engineer Wisconsin Geological and Natural History Survey; Engineer U. S. Geological Survey. Pp. xvi, 354; 54 plates; 17 figures in text. 1908. *Out of print.*

*Bulletin No. XXI. Scientific Series No. 6.*

The Fossils and Stratigraphy of the Middle Devonian of Wisconsin. Herman F. Cleland, Professor of Geology, Williams College. 1911. Pp. 206; 55 plates. *Out of print.* Ed. mcc.

*Bulletin No. XXII. Scientific Series No. 7.*

The Inland Lakes of Wisconsin; the Dissolved Gases of the Water and their Biological Significance. Edward A. Birge and Chancey Juday. 1911. Pp. xxi, 254; 10 plates, 142 figures in text; all diagrams of gases and plankton. *Out of print.* Ed. md.

*Bulletin No. XXIII. Economic Series No. 14.*

Reconnoissance Soil Survey of Northwestern Wisconsin. S. Weidman, with the assistance of E. B. Hall and F. L. Musback. 1911. Pp. viii, 103; 15 plates, including one map; 16 figures in text. *Out of print.* Ed. viiim.

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*Bulletin No. XXIV. Soil Series No. 1. (Economic Series No. 15.)*

Reconnoissance Soil Survey of Marinette County. Samuel Weidman and Percy O. Wood. 1911. Pp. 44, 4 plates, one map. *Out of print.* Ed. iiim.

*Bulletin No. XXV. Scientific Series No. 8.*

Sandstone of the Wisconsin Coast of Lake Superior. Fredrik Turville Thwaites. 1912. Pp. viii, 117; 23 plates; large map in pocket; 10 figures in text. Cloth bound. *Out of print.* Ed. Med.

*Bulletin No. XXVI. Educational Series No. 3.*

The Geography and Industries of Wisconsin. R. H. Whitbeck. 1913. Pp. viii, 65; 23 plates; 46 figures in text. *Out of print.* Ed. vim.

*Bulletin No. XXVII. Scientific Series No. 9.*

The Inland Lakes of Wisconsin. C. Juday. 1914. Pp. vi, 137; 29 maps; 8 figures in text. Cloth bound. *Out of print.* Ed. iim.

*Bulletin No. XXVIII. Soil Series No. 2.*

Soil Survey of Waushara County. A. R. Whitson, W. J. Geib, Guy Conrey and A. R. Kuhlman, of the Wisconsin Geological and Natural History Survey; and J. W. Nelson, of the United States Department of Agriculture. 1913. Pp. iv, 63; 3 plates, including one map. Paper bound. *Out of print.* Ed. iiim.

*Bulletin No. XXIX. Soil Series No. 3.*

Soil Survey of Waukesha County. A. R. Whitson, W. J. Geib and A. H. Meyer, of the Wisconsin Geological and Natural History Survey; and Percy O. Wood and Grove B. Jones, of the United States Department of Agriculture. 1914. Pp. iv, 82; 3 plates, including one map. Paper bound. Sent on receipt of 5 cents. Ed ivm.

*Bulletin No. XXX. Soil Series No. 4.*

Soil Survey of Iowa County. A. R. Whitson, W. J. Geib, T. J. Dunnewald and Emil Truog, of the Wisconsin Geological and Natural History Survey; and Clarence Lounsbury, of the United States Department of Agriculture. 1914. Pp. 61; 2 plates, including one map. Paper bound. *Out of Print.* Ed. iiim.

*Bulletin No. XXXI. Soil Series No. 5.*

Soil Survey of the Bayfield Area. A. R. Whitson, W. J. Geib, L. R. Schoenemann and F. L. Musback, of the Wisconsin Geological and

Natural History Survey; and Gustavus B. Maynadier, of the United States Department of Agriculture. 1914. Pp. 51, 4 plates, including one map. Paper bound. *Out of print.* Ed. iiim.

*Bulletin No. XXXII. Soil Series No. 6.*

Reconnaissance Soil Survey of North Part of Northwest Wisconsin. F. L. Musback, T. J. Dunnewald, Carl Thompson and O. I. Bergh. 1914. Pp. vi. 92; 11 plates; 10 figures in text, includes soil map. Paper bound. *Out of print.* Ed. xm.

*Bulletin No. XXXIII. Scientific Series No. 10.*

The Polyporaceae of Wisconsin. J. J. Neuman. 1914. Pp. iii, 206; 25 plates. Cloth bound. Sent on receipt of 50 cents. Ed. iim.

*Bulletin No. XXXIV. Economic Series No. 16.*

The Limestone Road Materials of Wisconsin. W. O. Hotchkiss and Edward Steidtmann. 1914. Pp. viii, 137; 2 figures in text; 41 plates and geological maps of counties. Cloth bound. Sent on receipt of 50 cents. Ed. iiimd.

*Bulletin No. XXXV. Economic Series No. 17.*

The Underground and Surface Water Supplies of Wisconsin. Samuel Weidman, of the Wisconsin Geological and Natural History Survey; and A. R. Schultz, of the United States Geological Survey, 1915. Pp. xv, 664; 72 figures in text; 5 plates, and a colored geological map of the state. Scale: 1 inch=16 miles. Cloth bound. Sent on receipt of \$1.50. Ed. iiim.

*Bulletin No. XXXVI. Educational Series No. 4.*

The Physiography of Wisconsin. Lawrence Martin, Associate Professor of Physiography and Geography, University of Wisconsin. 1916. Pp. xxii, 549; 206 figures in text; 41 plates. Includes relief map of Wisconsin. Cloth bound. *Out of print.* Ed. vim.

*Bulletin No. XXXVII. Soil Series No. 7.*

Soil Survey of Fond du Lac County. A. R. Whitson, W. J. Geib, L. R. Schoenemann and C. A. LeClair, of the Wisconsin Geological and Natural History Survey; and Guy Conrey and A. E. Taylor, of the United States Department of Agriculture. 1914. Pp. iv, 85; 5 plates; 2 figures in text. Includes soil map of the county. Paper bound. *Out of print.* Ed. iiim.

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*Bulletin No. XXXVIII. Soil Series No. 8.*

Soil Survey of Juneau County. A. R. Whitson, W. J. Geib, L. R. Schoenemann, and C. A. LeClair, of the Wisconsin Geological and Natural History Survey; and E. B. Watson, of the United States Department of Agriculture. 1914. Pp. iv, 93; 5 plates; 2 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. ivm.

*Bulletin No. XXXIX. Soil Series No. 9.*

Soil Survey of Kewaunee County. A. R. Whitson, W. J. Geib, and E. J. Graul, of the Wisconsin Geological and Natural History Survey, and A. H. Meyer, of the United States Department of Agriculture. 1914. Pp. iv, 84; 3 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. XL. Soil Series No. 10.*

Soil Survey of La Crosse County. A. R. Whitson, W. J. Geib, and T. J. Dunnewald, of the Wisconsin Geological and Natural History Survey; and Clarence Lounsbury, of the United States Department of Agriculture. 1914. Pp. 77; 5 plates; 2 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. XLI. Economic Series No. 18.*

A study of Methods of Mine Assessments and Valuation. W. L. Uglow. 1914. Pp. v, 73; 12 plates. Cloth bound. Sent on receipt of 50 cents. Ed. iimd.

*Bulletin No. XLII. Educational Series No. 5.*

Geography of the Fox-Winnebago Valley. R. H. Whitbeck, Associate Professor of Geography, University of Wisconsin. 1915. Pp. ix, 105; 28 plates. Cloth bound. Sent on receipt of 50 cents. Ed. ivm.

*Bulletin No. XLIII. Soil Series No. 11.*

Soil Survey of Vilas and Portions of Adjoining Counties. A. R. Whitson, T. J. Dunnewald, assisted by W. C. Boardman, C. B. Post, and A. R. Albert. 1915. Pp. 77; 4 plates; 2 figures in text. Includes soil map of area. Paper bound. *Out of print.* Ed. iim.

*Bulletin No. XLIV. Economic Series No. 19.*

Mineral Land Classification in parts of Northwestern Wisconsin. W. O. Hotchkiss, assisted by E. F. Bean and O. W. Wheelwright. 1915. Pp. vi, 378; 39 figures in text, 9 plates. Cloth bound. Sent on receipt of \$5.00. Ed. iiimd.

*Bulletin No. XLV. Economic Series No. 20.*

The Peat Resources of Wisconsin. Frederick William Huels. 1915. Pp. viii, 274; 20 figures in text, 22 plates. Cloth bound. Sent on receipt of 50 cents. Ed. iimd.

*Bulletin No. XLVI. Economic Series No. 21.*

Mineral Land Classification. W. O. Hotchkiss and E. F. Bean. *In preparation 1922.*

*Bulletin No. XLVII. Soil Series No. 12.*

Reconnaissance Soil Survey of North Eastern Wisconsin. A. R. Whitson, W. J. Geib, Carl Thompson, Clinton B. Post, and A. L. Buser, 1916. Pp. iv, 87; 10 plates; 3 figures in text. Includes soil map of Forest, Florence, Marinette, Oconto, Shawano and Langlade counties. Paper bound. Sent on receipt of 5 cents. Ed. viim.

*Bulletin No. XLVIII. Soil Series No. 13.*

Soil Report of Jefferson County. A. R. Whitson, W. J. Geib and O. J. Noer, of the Wisconsin Geological and National History Survey; and A. H. Meyer of the United States Department of Agriculture. 1916. Pp. ix, 77; 4 plates; 2 figures in text. Includes map of the county. Paper bound. Sent on receipt of 5 cents. Ed. ivm.

*Bulletin No. XLIX. Soil Series No. 14.*

Soil Survey of Columbia County. A. R. Whitson, W. J. Geib and Guy W. Conrey, of the Wisconsin Geological and Natural History Survey; and Arthur E. Taylor, of the United States Department of Agriculture. 1916. Pp. iv, 84; 4 plates; 3 figures in text. Includes map of the county. Paper bound. Sent on receipt of 5 cents. Ed. ivm.

*Bulletin No. L. Soil Series No. 15.*

Soil Survey of North Part of North Central Wisconsin. A. R. Whitson, W. J. Geib, T. J. Dunnewald, C. B. Post, W. C. Boardman, and A. R. Albert, of the Wisconsin Geological and Natural History Survey; and A. E. Taylor, L. R. Schoenemann, and Carl Thompson, of the United States Department of Agriculture, 1916. Pp. iv, 80; 10 plates; 3 figures in text. Includes soil map of Vilas, Oneida, Iron and Price Counties. Paper bound. Sent on receipt of 5 cents. Ed. viiim.

*Bulletin No. 51. Scientific Series No. 11.*

Inland Lakes of Wisconsin. Temperatures. E. A. Birge. *In preparation.* Sent on receipt of 10 cents.

*Bulletin No. 52A. Soil Series No. 16.*

Reconnaissance Soil Survey of South Part of North Central Wisconsin. A. R. Whitson, W. J. Geib, T. J. Dunnewald, C. B. Post, of the Wisconsin Geological and Natural History Survey; and A. E. Taylor, J. B. R. Dickey, and Carl Thompson, of the U. S. Department of Agriculture. 1918. Pp. 108; 4 plates; 2 figures in text. Includes soil map of Marathon, Lincoln, Taylor and Clark Counties. Paper bound. Sent on receipt of 5 cents. Ed. vmd.

*\* Bulletin No. 52B. Soil Series No. 17.*

Soil Survey of Wood County. A. R. Whitson, W. J. Geib, G. W. Conrey, C. B. Post, and W. C. Boardman, of the Wisconsin Geological and Natural History Survey, 1918. Pp. 86; 4 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiimd.

*Bulletin No. 52C. Soil Series No. 18.*

Soil Survey of Portage County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, L. P. Hanson, of the Wisconsin Geological and Natural History Survey; and Clarence Lounsbury and L. Cantrel, of the U. S. Department of Agriculture. 1918. Pp. iv. 79; 3 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiimd.

*Bulletin No. 52D. Soil Series No. 19.*

Soil Survey of Door County. A. R. Whitson, W. J. Geib, and H. V. Geib, of the Wisconsin Geological and Natural History Survey; and Carl Thompson, of the U. S. Department of Agriculture. 1919. Pp. 72; 3 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. 53A. Soil Series No. 20.*

Soil Survey of Dane County. A. R. Whitson, W. J. Geib, and G. W. Conrey, of the Wisconsin Geological and Natural History Survey; and A. E. Taylor, of the U. S. Department of Agriculture. 1917. Pp. iv. 86; 10 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. viim.

*Bulletin No. 53B. Soil Series No. 21.*

Soil Survey of Rock County. A. R. Whitson, W. J. Geib, Guy Conrey, and W. M. Gibbs, of the Wisconsin Geological and Natural History Survey; and A. E. Taylor, of the U. S. Department of Agriculture. 1922. Pp. 80; 5 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. ivmd.

*Bulletin No. 53C. Soil Series No. 22.*

Soil Survey of Green County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, F. J. O'Connell, Walter Voskiul, Max J. Edwards, and Kenneth Whitson, of the Wisconsin Geological and Natural History Survey; and A. C. Anderson of the U. S. Department of Agriculture. *In preparation.* Includes soil map. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 54A. Soil Series No. 23.*

Soil Survey of Buffalo County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, and O. J. Noer, of the Wisconsin Geological and Natural History Survey; and Clarence Lounsbury and L. Cantrel, of the U. S. Department of Agriculture. 1917. Pp. iv, 76; 4 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. 54B. Soil Series No. 24.*

Soil Survey of Jackson County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, of the Wisconsin Geological and Natural History Survey; and A. L. Goodman, of the U. S. Department of Agriculture. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 54C. Soil Series No. 25.*

Soil Survey of Waupaca County. A. R. Whitson, W. J. Geib, Martin C. Ford, and Martin O. Tosterud, of the Wisconsin Geological and Natural History Survey; and Clarence Lounsbury, of the U. S. Department of Agriculture. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 54D. Soil Series No. 26.*

Soil Survey of Outagamie County. A. R. Whitson, W. J. Geib, Martin C. Ford, and Martin O. Tosterud, of the Wisconsin Geological and Natural History Survey; and H. V. Geib, of the U. S. Department of Agriculture. 1922. Pp. 77; 3 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. 55. Soil Series No. 27.*

Report and map (General) of the North Half of Wisconsin. A. R. Whitson, T. J. Dunnewald, and Carl Thompson, of the Wisconsin Geological and Natural History Survey. This report including map is sold for 25 cents and can only be obtained from the Superintendent of Public Property, Madison.

*Bulletin No. 56A. Soil Series No. 28.*

Soil Survey of Milwaukee County. A. R. Whitson, W. J. Geib, and T. J. Dunnewald, of the Wisconsin Geological and Natural History Survey. 1919. Pp. 63; 2 plates; 3 figures in text. Includes soil map of the county. Paper bound. Sent on receipt of 5 cents. Ed. iiim.

*Bulletin No. 56B. Soil Series No. 29.*

Soil Survey of Racine and Kenosha Areas. W. J. Geib, H. W. Stewart, and Wm. Gibbs, of the Wisconsin Geological and Natural History Survey; and A. E. Taylor, of the U. S. Department of Agriculture. Includes soil map. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 56C. Soil Series No. 30.*

Soil Survey of Walworth County. A. R. Whitson, W. J. Geib, Vern C. Leaper, W. M. Pierre, of the Wisconsin Geological and Natural History Survey; and L. R. Schoenemann, and W. B. Cobb, of the U. S. Department of Agriculture. *In preparation* 1922. Includes soil map of the county. Sent on receipt of 5 cents.

*Bulletin No. 57. Scientific Series No. 12.*

The Phytoplankton of the Inland Lakes of Wisconsin. Part I. Gilbert M. Smith, Associate Professor of Botany, University of Wisconsin. 1920. Pp. 243; 51 plates. Cloth bound. Sent on receipt of 50 cents. Ed. iimd.

*Bulletin No. 58. Educational Series No. 6.*

Geography of Southeastern Wisconsin. R. H. Whitbeck, Associate Professor of Geography, University of Wisconsin. 1920. Pp. 160; 3 plates; 100 figures in text. Cloth bound. Sent on receipt of 50 cents. Ed. ivm.

*Bulletin No. 59A. Soil Series No. 31.*

Soil Survey of Sheboygan County. A. R. Whitson, W. J. Geib, A. H. Meyer, Geo. D. Scarseth, R. P. Bartholomew, and W. H. Pierre, of the Wisconsin Geological and Natural History Survey; and A. C. Anderson, of the U. S. Department of Agriculture. *In preparation.* Includes soil map. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 59C. Soil Series No. 33.*

Soil Survey of Washington and Ozaukee Counties. A. R. Whitson, W. J. Geib, Julius Kubier, Wm. H. Pierre, Vern C. Leaper, and F. J. O'Connell, of the Wisconsin Geological and Natural History Survey; and A. C. Anderson, of the U. S. Department of Agriculture. *In pre-*

paration 1922. Includes soil maps of the counties. Sent on receipt of 5 cents.

Note: Work has not yet been started on Bulletin No. 59B.

*Bulletin No. 60A. Soil Series No. 34.*

Soil Survey of Monroe County. A. R. Whitson, W. J. Geib, Olaf Stokstad, R. P. Bartholomew, and H. D. Chapman, of the Wisconsin Geological and Natural History Survey; and Ernest H. Bailey, Max J. Edwards, and A. C. Anderson, of the U. S. Department of Agriculture. *In preparation.* Includes soil map. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 61A. Soil Series No. 39.*

Soil Survey of Green Lake County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, H. D. Chapman, Kenneth Whitson, and F. J. O'Connell, of the Wisconsin Geological and Natural History Survey; and A. C. Anderson, Ernest H. Bailey, and Max J. Edwards, of the U. S. Department of Agriculture. *In preparation.* Includes soil map of the county. Paper bound. Sent on receipt of 5 cents.

*Bulletin No. 61D. Soil Series No. 42.*

Soil Survey of Adams County. A. R. Whitson, W. J. Geib, T. J. Dunnewald, H. W. Stewart, and Oscar Magistad, of the Wisconsin Geological and Natural History Survey; and Julius Kubier, and F. J. O'Connell, of the U. S. Department of Agriculture. *In preparation* 1922. Includes soil map of the county. Sent on receipt of 5 cents.

Note: Work has not yet been started on Bulletins Nos. 61B and 61C.

*Bulletin No. 63. Educational Series No. 7.*

Educational Collection of Wisconsin Rocks. Fredrik Turville Thwaites. 1921. Pp. 33. Only a small number of copies of this bulletin were printed to be sent out with the rock collection to Wisconsin High Schools. *It has not been sent out to libraries and exchanges.*

*Bulletin No. 64. Scientific Series No. 13.*

The Inland Lakes of Wisconsin. The Plankton. 1. Its Quantity and Chemical Composition. Edward A. Birge and Chancey Juday. 1922. Pp. ix, 222; 40 figures in text. Paper bound. Sent on receipt of 50 cents. Ed. iimd.

*Bulletin No. 65. Educational Series No. 8.*

The Geography of Southwestern Wisconsin. W. O. Blanchard, Professor of Geography, University of Illinois. (Formerly with Department of Geography, University of Wisconsin.) 1924. Pp. 105; 1 plate; 81 figures in text. Cloth bound. Sent on receipt of 50 cents. Ed. ym.

*Bulletin No. 66. Economic Series No. 22.*

Limestone and Marls of Wisconsin, by Edward Steidtmann, Professor of Geology, Virginia Military Institute, Lexington, Va. (formerly with Department of Geology, University of Wisconsin); with a chapter on the economic possibilities of manufacturing cement in Wisconsin, by W. O. Hotchkiss and E. F. Bean. 1924. Pp. ——; 6 plates; 19 figures in text. Cloth bound. Sent on receipt of 75 cents. Ed. ivm.

**2. Road Pamphlets.**

In 1909 the Survey issued four Road Pamphlets. On the organization of the Highway Commission the stock of these pamphlets still in the hands of the Survey was turned over to that body. Any applications for these pamphlets should be made to the State Highway Commission, Madison.

**3. Biennial Reports.**

The Survey has published fourteen biennial reports, which relate to administrative affairs only and contain no scientific matter.

First Biennial Report of the Commissioners of the Geological and Natural History Survey. 1899. Pp. 31.

Second Biennial Report of the Commissioners of the Geological and Natural History Survey. 1901. Pp. 44.

Third Biennial Report of the Commissioners of the Geological and Natural History Survey. 1903. Pp. 35.

Fourth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1904. Pp. 42.

Fifth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1907. Pp. 45.

Sixth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1909. Pp. 45.

Seventh Biennial Report of the Commissioners of the Geological and Natural History Survey. 1911. Pp. 55.

Eighth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1912. Pp. 38.

Ninth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1914. Pp. 40.

Tenth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1916. Pp. 42.

Eleventh Biennial Report of the Commissioners of the Geological and Natural History Survey. 1918. Pp. 40.

Twelfth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1920. Pp. 37.

Thirteenth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1922. Pp. 37.

Fourteenth Biennial Report of the Commissioners of the Geological and Natural History Survey. 1924. Pp. 44.

#### 4. Hydrographic Maps.

There have been prepared hydrographic maps of the principal lakes of southern and eastern Wisconsin. This work was in charge of L. S. Smith, C. E., Associate Professor of Topographic and Geodetic Engineering, University of Wisconsin.

		Size of plate, inches	Scale, inches per mile	Contour interval, feet
No. 1.	Lake Geneva (Out of print)	17.5x10.8	2	10
No. 2.	Elkhart Lake	15.5x13.1	5	10
No. 3.	Lake Beulah	25.5x20.0	6	10
No. 4.	Oconomowoc-Waukesha Lakes	29.8x19.1	2	10
No. 5.	The Chain of Lakes, Waupaca	21.7x20.6	6	10
No. 6.	Delavan and Lauderdale Lakes	22.5x16.8	4	10
No. 7.	Green Lake	26.0x17.8	3.2	20
No. 8.	Lake Mendota	23.7x19.5	6	5
No. 9.	Big Cedar Lake	18.0x13.5	2.9	10
No. 10.	Lake Monona	17.6x17.3	4	5

In all of these maps the depth of the lakes is indicated by contour lines, and by tints in all except No. 1. They are sent on receipt of 10 cents each and may be had either mounted in a manila cover, or unmounted.

#### 5. River Profile Maps.

Wisconsin River .....	11 sheets
Eau Claire River .....	2 "
Peshtigo River .....	4 "
Black River .....	3 "
Flambeau River .....	6 "

The above named maps were issued by the United States Geological Survey based on cooperative work with the Wisconsin Geological Survey. The stock of these maps is now deposited with the Survey and the maps will be sent on the same terms as they were by the United States Geological Survey, viz: 5 cents per sheet, postpaid.

#### *Geological Model of Wisconsin.*

The Survey has prepared a model which shows in great detail the topography of the state. It is designed for use in schools, libraries, and similar public institutions, and is 49 inches by 45 inches in size. It is supplied to such institutions in Wisconsin at the cost of making.

#### *Geology and Road Map of Wisconsin, 1911.*

A geological map of the state has been prepared and is now on sale. This is a large wall map 54 inches wide and 62 inches long. It shows all the roads of the state and the geology. The main traveled roads

between cities are prominently shown by a red color. All counties, cities, villages, towns, Indian Reservations, railroad lines, rivers and lakes are shown. In the corners of the map is the legend, which gives the name, character, thickness and economic products of the various geologic formations; an outline of the geologic history of the state; and a table of elevations of the prominent physiographic features of the state. At the bottom are three sections showing the geologic structure. Under authority of the legislature this map is distributed to all the schools of the state by the State Superintendent of Public Instruction. The map is sold to other persons by the state at the cost of printing and can only be obtained from the Superintendent of Public Property. With substantial cloth mounting and roller and stick at bottom and top, the price is \$1.00. The folded paper map suitable for sectional mounting is sold for 30 cents.

*Educational Collection of Wisconsin Rocks and Minerals.*

This collection comprises 39 specimens and is designed for use in high schools and other institutions in which general science, elementary geology, physical geography, or geography of Wisconsin is taught. In order to insure that this expensive collection will be preserved in good order, a box has been made which permits the specimens to be displayed for class use in convenient form. It is sent out for practically the cost of the box—\$10.00.

All correspondence relating to the Survey should be addressed to

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Madison, Wis.



